NOTES ON THE DISTRIBUTION OF THE USEFUL MINERALS IN SARAWAK

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Among the numerous works that have appeared during the last forty years having reference to that narrow strip of the N. W. Coast of Borneo now known as the Sarawak Territory, there occur suggestions that this portion of the island will be found wealthy in mineral resources at some future day, when the progress of exploration and a larger influx of European enterprise, shall have indicated their extent and led to their full development.

In point of fact these ideas are not of recent birth. From the day when the companions of the hopeless Magelhäens, cast anchor off Brunie, now some three hundred years ago, up to the early part of the present century, when Hunt presented his report on the island of Kalamantan to Sir S. Raffles, the "great and rich island of Borneo" has been encircled with a fictitious halo of reputed wealth in precious mineral deposits.

It has been the office of time, remarks Temminck, to dissipate these golden fancies, and whether they will ever be realised, or even seriously revived, is problematical; but, nevertheless, there does exist a certain amount of solid foundation for the idea, that Borneo is well furnished with the useful metals and minerals, although for the most part these are not such as would have attracted the attention of the early voyagers in the East. And it is in connection with this wider field—the mineral resources of Borneo as a whole—that the following notes on the minerals of Sarawak are offered.

Before proceeding to enumerate the various minerals of economic value heretofore observed in Sarawak, and to note their modes of occurrence, distribution &c., it will be advisable to glance at the goelogical features of the district of Upper Sarawak (Proper), both as being the only locality in which *workable* deposits of mineral ores have been discovered, and because it furnishes us in a greater or less degree with an epitome of the geological structure of the major part of the Territory.

Briefly described then, this district consists of an ancient compact blue Limestone (Paleozoic?) on which is superimposed unconformably a thick series of sandstones, conglomerates, and clay-shales, constituting the most extensive series of beds in this part of Borneo; and on these last lie strata of clay-shales, alluvial clay, river gravels, &c., of very recent origin. Piercing the limestone and sandstone, we find granite and a variety of igneous and trappean rocks—basalt, porphyrite, greenstones, &c., these latter being developed in great abundance in the Antimony districts, where they are in immediate contact with the limestone. The latter formation, in which the lodes of Antimony are seen in *situ*, is locally rich in fossil organic remains, but I am unable to say whether they have been examined by a competent paleontologist with a view to approximate the age of the rock; the planes of stratification can seldom be made out with any approach to certainty, but where they are evident, they show that the originally horizontal beds have been up-tilted almost on end and much denuded; and there is abundant proof that a very considerable interval in time elapsed between the close of the limestone formation, and the commencement of the succeeding sandstone series.

The sandstone shales have also undergone much disturbance all over this portion of Borneo, although, like the limestone, sometimes retaining their horizontality. They are generally impregnated with per-oxide of iron, and as is so often the case with such rocks, seem quite barren of fossils, except in the coal-measures. It is in this formation that the cinnabar deposits of the country occur.

Both limestone and sandstone have been enormously denuded, the latter rising in isolated tabular mountains, or short peaky trends, with an altitude above the sea varying from 1,500 feet and separated by undulating valleys, in which the limestone appears, sometimes in low hilly tracts varying from 200 to 1,200 feet in elevation, sometimes in solitary crags, but invariably with long lines of old sea-cliffs and bald scarps. When accident removes the veil of dark green jungle from their faces, they present to view surfaces fretted by a thousand deep rifts, and fissured and jointed in every imaginable direction.

In the intervening lowlands we have uniformly a deposit of dark yellow felspathic clay, apparently unstratified, and varying in depth from a few feet to 80 feet or more, which is derived from the degradation, and, I think, decomposition *in situ*, of the clayey sandstones, clay shales, and, especially, the felspathic

intrusive rocks of igneous origin, so abundant in the district. Associated with this clay, and mostly of more recent date are superficial deposits of puddingstone, river-gravels, &c.

The intrusive igneous rocks appear indiscriminately all over Upper Sarawak as mountains and hills, and very commonly in the form of dykes, which, with some few reefs of siliceous veinstone, seam the country in great numbers between the more elevated masses. They consist for the most part of varieties of porphyrite, very decomposable, and more seldom of basalt. The volcanic action which caused their eruption would seem to have been in operation at a period subsequent to the formation of all the stratified sedimentary rocks of the district, and antecedent to only the most recent of superficial deposits. It is in immediate connection with these rocks that we find the deposits of antimony, arsenic, and cinnabar; and as there is reason to believe that they occupy fissures caused by the eruption of the volcanic rocks, and that their deposition took place after the cessation of volcanic action, we arrive at a remarkably recent date for the formation of the mineral lodes at Upper Sarawak.

Such in outline are the geological features of Upper Sarawak. Other formations and many other varieties of rocks, are to be met with in the Territory, but it is not necessary to particularise these, as they are not connected with the mineral deposits of the country, so far as we know, and are therefore foreign to the subject of these notes.

The minerals and mineral ores of Sarawak, in relation to their local distribution, may be summarized as follows, the names of those which have only been observed in traces being italicized.

District of Sarawak Proper (including Lundu and Samarahan),—Gold, Antinony, Arsenic, Argentiferous-Arsenic, Cinnabar, *Cobalt, Nickel, Manganese, Copper,* Iron Diamond, Aquamarine, *Coal.*

District of Sadong.—Gold, Coal, *Diamond, Iron, Cinnabar.*
District of Batang Lupar.—Gold, Coal, *Iron, Antimony.*
District of Rejang.—Coal, Iron, *Arsenic, Antimony, Nickel, Gold.*
District of Mukah and Bintulu.—Coal, *Antimony.*

In the districts of Saribas, Kalakah and Oyah, I have no reliable information of the occurrence of useful minerals. A number of the above mentioned species are known to have been detected in other parts of N. W. and W. Borneo beyond the limits of the Sarawak territory, viz., Gold, Antimony, Arsenic, Copper, Cinnabar, Iron, Diamond, and Coal, some in work-

able quantities and some in traces; and in addition platinum molybdenum, petroleum, catseyes, and spinelle ruby have been observed. In Sir J. Brooke's "Private Letters" mention is made of a large stone called the "Brooke diamond" which on examination proved to be a white topaz, but the precise locality whence it was obtained is not specified, although we may surmise that it was a genuine Sarawak stone.

I find also in a work on China entitled "The Middle Kingdom" (1848) mention of Corundum being imported from Borneo for the use of Chinese lapidaries; no authority, however, is cited for the occurrence of this mineral in Borneo: the note probably refers not to Corundum, properly so called, but to diamonds, brought from Landak and Sarawak.

In the above enumeration it is noteworthy that Sarawak Proper exhibits all the minerals of which traces have been detected in the other districts, and several others besides. When we consider that it is the only portion of the Territory in which a systematic search has been attempted (generally by amateurs) and that there is a close general similarity in geological constitution over the whole of the N. W. coast of Borneo, there is fair ground for conjecture that available deposits of one or more of the above mentioned minerals, will be discovered in some other localities in which traces only have been detected as yet.

Gold occurs in the form of fine sand, or minute flattened plates in alluvial deposits over a great part of Sarawak. Washings are carried on in Upper Sarawak at Bau, Paku, Gumbang, &c., in Samarahan at Sirin, in Sadong at Malikin, and in the Batang Lupar at Marup. The operations are wholly superficial, although at Marup and Bau, the principal Chinese washings in the country, the stratified clays belonging to the Sandstone formation, and containing at the latter locality decomposed porphyritic dykes have been cut into to some extent. The precious metal has never to my knowledge been regularly mined for in Sarawak, nor indeed has it been discovered *in situ* it its original matrix, except in the case of the gold contained in the veinstones and quartz-reefs of the Antimony district, and that associated with a lode of argentiferous arsenic at Bidi. The alluvium of the limestone caverns and fissures, and especially the sands in the beds of streams have yielded sufficient to induce the natives to work in such spots. The washing is carried on partly by Malays, who are usually gamblers and work only at intervals, but chiefly by country-born Sambas Chinese. Their mode of operation has been fully described by Crawfurd, Horsfield, St. John, and others, and it will therefore be unnecessary to enter into any details here.

Nuggets are of extremely rare occurrence and I have never seen one of any size, but if the Chinese are to be credited, some of very considerable weight have been met with in the adjacent Sambas District. St. John mentions having seen one of 7 oz., taken from the auriferous clay at Krian near Bau, and this is the largest which I have heard reported on credible authority to have been found in Sarawak. The gold dust is usually in a state of the finest comminution, but I have seen samples from Kumpang, near Marup, composed of fine dust intermixed abundantly with thin flat plates of the metal of from $\frac{1}{3}$ to $\frac{1}{12}$ inch diameter—a form which has been ascribed to some original laminated structure in the present matrix. I am informed that similar plates have been detected in the siliceous veinstones of the antimony lodes; but where I have had the opportunity of seeing the gold in these veinstones it appeared in very minute sparsely scattered specks without a sign of running into plates or veins. The veinstones are now and again found to contain a very profitable percentage, according to the estimate of the Chinese, who quarry the stone in a superficial way, and pounds it in wooden mortars with iron rammers. One block of siliceous matrix (about 15lbs.) at Paku containing some 20 per cent of grey antimony, when thus crushed yielded about $12 worth of gold, but this result was quite exceptional. At Jibong both the white quartz and the black amorphous siliceous veinstones are crushed, and of these two the latter is considered to yield the higher percentage of metal. Both in crushing the stone and in washing the alluvial clays and gravels the find is very uncertain, and good "hauls" seem few and far between. Marup, Bau, and Paku have afforded remunerative washings, and Sirin in a less degree. The succession of the superficial deposits in the last locality are as follows:—

1. Vegetable mould.
2. Unstratified Felspathic clay.
3. Clayey Gravel.
4. Uptilted indurated clay-shales.

The whole section to the basement-rock of clay is only 5 or 6 feet in thickness, and it is in the stratum of gravel that the gold is found, associated with small rolled fragments of cinnabar and the clay-ironstone which abounds all over the gold and antimony districts of Sarawak. The components of the auriferous gravel are granite, quartz, sandstone, impure-agate, porphyrite, &c. The surrounding country is made up of steep low hills of indurated clay-shales and clayey sandstone with yellow felspathic clay overlying, and is seamed with dykes of hornblendic trap-rocks; and a short distance to the S. and W. limestone hills appear.

The quality of Sarawak gold varies with the locality in which it is found. Thus Marup gold at $32 to $34 per bongkal according to the supply, Sadong gold at $26, whilst Paku gold is quoted at $28 per bongkal, the difference being estimate by the whiteness of the metal which is dependent on the amount of silver existing in natural alloy with it. No scientific analysis has been made of Sarawak gold so far as I am aware, but it would doubtless be very similar in result to the analysis of Bornean gold given by Crawfurd, which I have taken the liberty of transcribing below, as his valuable work has long been out of print.

Name of gold taken from the district which produces it.	Country where situated.	In 100 parts. of gold dust.		Gold.	Silver.	copper	Silver and copper
		Dross.	Metal.				
Gold of Ombak ...	Borneo.	3.75	96.25	88.19	8.51	3.30	11.81
„ Sanga ...	ditto.	4.96	95.04	90.97	3.65	3.38	9.03
„ Lara ...	ditto.	3.83	96.17	86.11	5.90	7.99	13.89
„ Banjar Laut ...	ditto.	2.66	97.34	90.45	4.34	5.21	9.55
„ Pontianak ...	ditto.	14.05	85.95	82.99	16.14	0.87	17.01
„ Jambi ...	Sumatra	5.47	94.53	91.84			8.16
„ Sambas ...	Borneo.	9.00	91.00	83.68			16.32
„ Palembang ...	Sumatra	2.11	97.89	98.75			6.25
„ Montradok ...	Borneo.	12.02	87.98	84.09			15.91

The dust brought to market in Kuching is generally unadulterated, as the mysteries of galvanic gilding are as yet unknown there. There is little risk in purchasing if ordinary care be exercised.

With regard to the annual produce of gold in the Territory, there are no reliable data for even approximating the total amount produced. Mr. Low of Labuan—whose work, in spite of its being somewhat out of date, is the most trustworthy yet written on Sarawak—places the yearly export of gold from the Territory at 7000 ounces. Although nominally all gold carried out of the country must be declared, it is beyond doubt that quite as much leaves Sarawak in a private way as is declared to the Export Office in Kuching, while a still more considerable portion of the annual out port is bought up and remains in the country, without in any way showing in the trade returns. The same remark will apply to the produce of diamonds; and in the "Summary of Exports" given below it must be borne in mind that the figures are purely nominal, and represent amounts certainly far below the minimum value of even the annual export of these two minerals—much more so of the net annual produce.

In connection with the consumption of gold in the Territory, it may be remarked that none of the savage tribes of this part of Borneo seem ever to have made use of this metal notwithstanding their intercourse with Malays, and in a less degree with the Chinese, during at least several centuries past. I have never known an instance of a Sea-Dyak or Land-Dyak, a Kyan or Bakatan seeking gold on his own account, and manufacturing it into any description of ornament, however rude.

When we endeavour to trace out the origin of the gold in Sarawak, we find the immediate source of the metal, in the gravels and alluvial clays and in some of the clay-shales, which so thickly mask the older formations in N. W. Borneo, and out of these beds it is being swept continually by running water. It is evident however, that so far we have traced the source but a single step back; and the conclusion at which I have arrived, from observation of a considerable number of sections in different parts of the country, is that the auriferous strata of Sarawak Proper are derived immediately from the waste of siliceous and porphytic dykes, associated with the system of antimony and arsenic lodes developed in that locality. Similar strata however in other localities (the Batang Lupar washings for instance) appear rather to have been rearranged more than once; so much so, in fact, that the original home of the gold they bear can no longer be guessed with any approach to certainty: and the only clue to the problem is to be found in the circumstance that invariably in these latter districts there is evidence of considerable metamorphic action among the constituent rocks of the several localities. It is highly probable that much of this gold originally lay in quartz rock, as is the case in many places in Sumatra and in the Malay Peninsula, and *may* be the case to a limited extent in the less known parts of Sarawak; but even if auriferous reefs are discovered at a future day in accessible situations, it is more than doubtful whether they will afford a field for the European speculation, especially since an analysis of a quantity of the auriferous veinstone at Bau, by a competent European metallurgist, has failed to give such a result as to tempt further operations.

Silver and Arsenic:—Some years ago a lode of native arsenic was worked at Bidi in conjunction with the antimony at the same spot, but the mine was subsequently abandoned as the ore scarcely repaid the cost of export. Realgar and Orpiment were observed, but not in quantity; the former is found in traces in the Upper Rejang, a district wholly unexplored by Europeans, and in the Baram. Argentiferous arsenical ore also occurred at Bidi, and an attempt was made to extract the Silver and gold

contained in it; but this project was also abandoned as unprofitable, the precentage of the precious metals in a ton of the residuce left bp smelting out the Arsenic being too small to repay the cost of their extraction.

Silver is unknown in the Territory, except in the connection here stated, or naturally alloyed with the gold. It is not improbable that the argentiferous arsenic at Bidi may be found richer in silver than has yet appeared, but the analyses made heretofore have discouraged this hope. A ton of the ore being calcined, yielded the following result:—

	oz	dwt.	gr.
Silver	5	16	8
Gold	1	11	4

This was considered an average sample, although slightly higher precentages were obtained by another trial.

Manganese, Cobalt and Nickel:—The first of these minerals is found in small quantities in the Bidi mines, but is not, I believe, sufficiently abundant to be of any practical value. Cobalt and Nackel I have not met wiuh myself, but Mr. Low has the following passage in his "Sarawak" on their occurrence:—"Nickel in found over the whole Territory of Sarawak, particularly in the gold and tin *(sic)* districts; in the former it is very abundant, combined with iron and Cobalt: it has not yet been worked."

Iron is disseminated throughout the whole Territory, and all the clay-shales and sandstones are more or less ferruginous; those in the gold districts being often impregnated with the peroxide. No dedosits of iron-ores are known in this country of any commercial importance. The richest specimens come from the Upper Rejang. Tne Kayan tribes inhabiiing this district smelt their own iron, using charcoal only, in their own rude furnaces, and the steel they manufacture is preferred to that of European make. The ores I have seen brought down from Balui, the right-hand branch of the Rejang, are (1) a very pure oxide with metallic fracture and strongly magnetic, and (2) a botroidal argillaceous ironstone, not magnetic, with dull purple clayey fracture, very hard, and much worn and rolled. This latter ore is said to be dug out of alluvial clays.

A clay-ironstone having a peculiar scoriaceous appearance is scattered though the alluvial clay of Upper Sarawak and is especially abundant in the gold and antimony districts—indeed

one meets this ore all over the country. It is frequently rich enough to show a metallic fracture and bears a close resemblance to the ironstones described by Horsfield es appearing in such profusion in the tin-mining districts of Banka. I have never observed this ore, however, in Sarawak in the extensive veins and reticulations mentioned by him; but, if one may be allowed to form and opinion from the written descriptions only of Horsfield and Logan, these iron ores belong to the same class as the Ironstone of the former writer, and the Lateritic iron-ores of Logan's writings on the Malay Peninsula.

Copper Lead and Tin.—The first of these minerals has been detected in very unimportant traces in Upper Sarawak on the Dutch border; the two latter, though often reported, have not been discovered even in traces. Galena is *said* to have been obtained in the vicinity of Bidi, but I am not in a position to vouch for the accuracy of the report. Copper occurs in minute quantities in the form of green and blue carbonate in connection with the antimony lodges at Busan, but there is no evidence at present to lead us to suppose that any workable deposit of Copper ores will be discovered in Sarawak. As to Tin, on the contrary, there is reasonable ground for expecting that it will be found to exist; having regard to the close similarity in geological constitutions between certain parts of the Territory, and the richly-stanniferous localities of Banka and Malacca.

Antimony has long been known as the staple mineral export of Sarawak. It ores are distributed over the whole of the Territory as well as being found beyond the frontiers in Brunei and in Dutch Borneo; but they have not been ascertained to be in workable quantity in any part of the island except in the district of Upper Sarawak (Proper), where, however, all the more accessible deposits are exhausted.

The most productive localities worked have been the Busan veins, the Jambusan, Busan, and Piat surface ore and the Bidi lodes and surface ore. At all these places, with perhaps the exception of Bidi, the out-put has either ceased altogether, or has greatly decreased during the past three years, but a great deal of inferior ore is still turned out. Bearing in mind the history of the mining operations as Jambusan, a new find may yet be heard of even in the abandoned working—so easy is it in a country densely covered with jungle, like Borneo, to go on working for months and years within a few yards of a valuable deposit which is revealed at length by mere accident. In addition to the above-mentioned localities, antimony has been marked

at Grogo and Sikunyit; and it has been observed in traces between Ahup and Gumbang, at Sirin in the Samarahan, in the Sadong district, at Marup in the Batang Lupar, and in the Intabai and Poi tributaries of the Rejang river, and one good specimen of sulphide has come under my notice from the Kagan districts of the Upper Rejang.

These wide-spread traces cannot be referred to a single centre of dispersion such as it might be supposed the Upper Sarawak field would present. They point to the presence of one or more undiscovered accumulations of antimony ore to the east of Sarawak Proper, though whether within the boundaries or at a short distance beyond, cannot now be said. In Kanowit the traces are tolerably abundant, but their great distance island renders it vain to hope they will be followed up for many years to come, if at all.

The ores commonly worked are native antimony; gray sulphide, and the "oxide" or "red ore" (oxy-sulphide). Native antimony occurs in the form of worn rounded pebbles in alluvial flats in the immediate vicinity of the vein-bearing limestone, and especially in the gullies and crevices so characteristic of this rock which are always more or less filled with a debris of clay and fragments of veinstone and ore. My brother—to whom I was indebted for many of these notes—informed me that he once observed native antimony forming part of a vein, and in this single instance it was scattered throughout a small horizontal lode of the sulphide. The ore in this form is not found in large quantities, but as it contains a minimum of impurities, approaching more nearly to regulut of antimony than any of the other varieties, and therefore requiring no preparation before being exported, it is always secured where met with. The Busan hills have proved the richest depository of this ore.

The oxide, like the foregoing ore, is generally obtained in rolled fragments and pebbles which are often seen to be only blocks of sulphide, partially oxidized, and preserving their original lamellar structure. It is found in the same situations as the native antimony, but in much larger quantities. It has been hitherto exported in its rough state, and is the least valuable of the ores of antimony owing to the difficulties it presents in reduction. The largest boulder of which I have heard weighed some 8 cwt., but the fragmeuts are almost invariably small, weighing from a pound to thirty or forty pounds. The chief supply has been obtained from Boan, Piat, and Paku localities around the base of the Busan hills.

By far the principal part of the antimony, however, is afforded by the sulphide or common gray antimony, which occurs both in the form of lodes in the limestone rock, and in deposits of rolled boulders in the valleys contiguous to the hills bearing these lodes. These latter sources of the ore are now worked out, and the supply is dependent almost wholly on the vein-mining. The percentage in ores werked, runs from 18 to 80 per cent. The Ahup ore, of which only a few boulders hav ebeen met with is the richest known, giving a percentage of 80 per cent of pure sulphide. But this is exceptional; in practice the ores if very rich or very poor are mixed with stuff of average quality (No. 2.) preparatory to smelting. The bulk of the ore has a distinctly lamellar structure, and commonly has a shining steel-gray lustre when freshly fractured; sometimes it is iridescent, presenting a rich play of blue, violet and crimson hues like variegated copper-ore. The poorer varieties exhibit a starry pattern of needless radiating through the white veinstone; or the antimony will traverse the matrix in long slender spikes, or be disseminated in specks in the poorer sorts. More rarely one finnds masses of tangled acicular crystals which are now and then endomorphous in hexagonal prisms of quartz crystal. The gangue is generally siliceous, sometimes amorphous, sometime crystalline, or, less commonly calc-spar (rhombic); and when a vein of white siliceous gangue is followed into the rock, in invariably runs into a dark gray amorphous siliceous veinstone, of extreme hardness and with little or no oer in it. This dark-coloured veinstone appears with the antimony in all situations and the oer is always intimately mixed with it, the stone itself when magnified being seen to be thoroughly impregnated with the sulphide in the form of minute needles. As a general rule vein-ore is rich, but runs poorer as the lode is worked in, the block spar gradually preponderating and ultimately replacing the antimony altogether. Lodes in which the matrix is calc-spar are rarer those in which the gangue is siliceous.

The arrangement of the contents of a vein often differs entirely in portions only a few feet apart: calc-spar, black-spar, crystalline white quartz, and antimony being intermingled confusedly one with another—each one running for a few feet or inches in a narrow ill-defined band and then being lost in some other; but in other lodes uniform bands of calc-spar or quartz will be found coating the walls of the fissures, with a single rib of ore running between. Instances have occurred of large masses of sulphide rich on the surface being found, when worked down to the limestone, to terminate in an insignificant vein of very poor ore; exactly as if there had been a continued overflow-

ing and accumulation of ore from a kind of top-hole, which is represented by the small vein.

The veins are natural fissures in the limestone, having their walls usually clear and well defined, and the adjacent rock is seldom metamorphosed to any noticeable degree. In the Busan hills the lodes have a general N. W and N. S. and strike and dip at angles varying from 20° to 50°, the amount of dip not being a constant in the same lode; but in the Jambusan valley, about a mile distant, a lode was found striking almost due E. and W. and this was at a considerably lower level than the Busan veins, of which a series of four or perhaps five distinct lodes is to be observed cropping out in one spot, each above the other, with short intervals. The lodes at Bidi are said to dip at a very high inclination, but I have had no opportunity of examining this locality. The working face ranges from six feet to a few inches in depth, and the yield of any single vein is very intermittent.

The adventitious minerals, found associated in the vein with the sulphide, are gold and copper in the gangue, and gold, silver, native arsenic and realgar in the ore. The last-mentioned sometimes spots the sulphide of antimony with small pockets of orange-red crystals, and the ore at Bidi is not unfrequently stained red from the same source. The existence of quicksilver also in some form or other is attested by the presence of globules of metallic mercury in the flues of the reverberatory furnaces, where it has condensed after sublimation in the smelting chamber, and has been deposited together with the white oxide of antimony.

In seeking to decipher the geological sequence of events which resulted in the produce of the system of antimony veins in upper Sarawak, the observer is at once brought face to face with rival theories of the production of mineral veins as a whole. There is no evidence to indicate that the antimony lodes derive their metallic contents by any process of segregation from the rock in which they lie, although portion of the gangues may have been locally so derived; and the true interpretation of the phenomena they present is therefore limited to the inquiry, whether the various minerals were injected in molten state into the including fissures, or were deposited gradually and from solution, by the passage of hot spings through the limestone rock. I do not feel competent to give an opinion on a theoretical matter of this kind, which, to be at all reliable, must be founded on a wide knowledge of strictly chemical geology; but I may here state that M. Gröger, a geologist and mining engineer employed by

the Borneo Company to report on the antimony mines, is decidedly in favour of the aqueous, as against the igneous theory of the origin of the antimony.

Quicksilver. The mineral was discovered *in situ* about seven years ago, by the indefatigable exertions of Messrs. Helms and Walters of the Borneo Company Limited, who prospected over the whole of Sarawak Proper, and ultimately succeeded in tracking the small fragments of cinnabar that are scattered over the district, to a hill on the right bank of the Staat river, and between it and the Sibugoh mountains.

During the progress of the exploration, a rough but serviceable sketch-map was executed, embracing Sarawak Proper and the Upper Samaraham, on which the positions of the principal deposits of antimony and cinnabar will be found accurately marked.

The Hill containing the cinnabar—for it is in this form as usual that the quicksilver occurs—is known by the name of Tagora, and is, or rather was, a steep twin-peaked mass of semi-metamorphic rock, rising to an elevation of about 800 ft. above the sea-level, in the upper parts of which the ore is found deposited capriciously in strains, pockets and strings, with now and again a little metallic mercury.

The component rocks are argillaceous shales, with sandstones interbedded; these have been very extensively disturbed and contorted, and the former are as I have said, partially metamorphosed into an impure state, glittering with cubical iron pyrites, and, in the higher portion of the hill, full of cutters of carbonate of lime. Nodules of black shale occur here and there in the state which is, in appearance, amygdaloidal, through being often thickly spotted with calc-spar, baryta, and pyrites. Some layers of sandstone which I observed cropping out at a very high angle on one of the peaks, did not seem to have been affected in the same degree with softer shales by the metamorphic action, and still retained their normal structure, though hardened to such a degree as to be most refractory in working.

The ore is found in the slate, rarely in the sandstone, and, as is the case with all known deposits of Cinnabar, is distributed with great irregularity in the matrix. Hence the yield has proved extremely variable, and at times the ore has seemed to be lost altogether. No such thing as a lode can be said to exist, though short strings are met with. One of these attained a face of six inches, and was traced down to a depth of many fathoms.

The most considerable quantity of ore has been gained, not by vein-mining, but by washing in the felspathic clays flanking the western aspect of the hill. These clays afforded pure stream Cinnabar in great abundance, as well as hundreds of rich boulders of ore-bearing rock that had been denuded from the upper parts of the hill. This source of wealth, however, was limited, and may be regarded as exhausted.

A search for fresh deposits has been instituted from time to time. Traces of Cinnabar have been detected behind the Sibugoh mountain and in the Samaraham and Sadong districts; and traces of metallic mercury have been reported on good authority at Marup in the Batang Lupar; and at Gunong Gading, a few miles to the west of Tagora, ore has been discovered *in situ*, and is being worked. The Gading deposits are altogether smaller and much poorer than those at Tagora. The general geological features of the two hills are similar, but the matrix at Gading is more siliceous and more highly metamorphosed, though at the same time decomposing rapidly on exposure to atmospheric influences, as is also the case with the Tagora rock. The character of the Cinnabar differs from that of the Tagora deposits, being soft and crystalline, and the ore in the stream-washing is small and very friable, and so abundantly mixed with iron-pyrites as to make it impossible to separate the two minerals by simple hand-washing.

As with the antimony there is evidence of the association of minute quantities of quicksilver, so too, antimony (sulphide) has been observed in juxtaposition with the Cinnabar in the same fragment of veinstone at Gading.

With regard to the origin of these deposits of Cinnabar, it is almost certain that they were produced by the passage of heated vapours bearing quicksilver and sulphur in a state of sublimation, which were deposited by the cooling of the vapours as they approached the surface of the earth. The peculiar and irregular mode of deposition of the Cinnabar, and the facts that the lower the miner goes the less abundant the ore becomes, and that no definite "run," or fissure vein, is observable, all point in this direction. It is confirmatory of this view, that the surrounding shales and sandstones are all more or less highly impregnated with peroxide of iron, whilst in the metamorphic ore-bearing rock, iron is scarcely visible except in the form of pyrites, i.e. in combination with sulphur, which can only have risen from below in a state of sublimation, and has seized on the iron and collected it in this form. Assuming a large proportion of sulphur in the

local subterranean exhalations containing quicksilver, the formations of both pyrites and cinnabar may be readily explained.

Coal is found in many localities on the N. W. Coast of Borneo and crops up in the Sarawak Territory at Simunjan, at Lingga and other spots in the Batang Lupar district, in the Rejang, and in the Mukah and Bintulu rivers. It was formerly worked at Sadong, and the mine has recently been re-opened by the Government, and now supplies regularly a small quantity of fair steam coal. For the past two years an exploration of the Lingga seams has been in progress, and it is hoped that this field will be shortly worked on a large scale. The other outcrops of coal of importance are those of Mukah and Rejang: both in such inaccessible situations as to be for the present quite useless, although, so far as is known, of good quality and considerable extent. The varieties of the mineral found are anthracite and cannel coal, both of which appear to be remarkably free from pyrites and sulphur. The Cannel coal has been found to give a very small percentage of ash (1.20 according to an analysis by Dr. Stenhouse) but this advantage is counterbalanced by the presence in it of considerably more Nitrogen than is generally exhibited by such coals. The ordinary Lingga coal is very nearly identical in composition, as regards the proportion of carbon and hydrogen, with the Hartley-Newcastle coals, as Dr. Stenhouse has lately shown by the following analyses conducted in duplicate.

	Carbon	Hydrogen	Sulphur	Oxygen & Nitrogen	Ash
Sarawak Coal	81.41	5.40	0.68	4.47	8.04
S'wak Cannel Coal	72.21	5.43	0.85	20.31	1.20
W. Hartley Main	81.85	5.29	...	...	...
Newcastle Hartley	81.81	5.50	...	...	...

It would be premature to take these analyses of small samples, however exact, as affording reliable data on which to base an opinion as to the value of the bulk of the Sarawak Coal. Nevertheless the trial of the Lingga coal lately conducted on board S. S. "Delhi" and Baroda" (Peninsula and Oriental Company), go rather to confirm, than to throw discredit on the laboratory analyses. Two 40-ton samples were burned under ordinary conditions of wind and speed, on board these vessels, and the coal was found with no more than the usual care from the stokers, to burn clearly with little smoke, and leave a residuum of only some 16 per cent in the furnaces, consisting of light and easily broken clinker. It would seem, however, that under severer test-conditions the coal would be found to burn a good deal faster than the best North Country Coals, unless mixed with good ordinary steam-coal. I should add that

these samples being procured under difficulties as to working appliances and carriage, did not fairly represent the condition in which the mineral would by put into the market after mining operations had been regularly opened, and therefore the results obtained are all the more encouraging.

Diamond: Aquamarine.—There is some reason for believing that the diamondiferous deposits of Sarawak are more valuable than has yet appeared to be the case. No systematic operations in the search for these precious stones have ever been carried on in the country. The only people who pursue diamond-washing as a means of livelihood are the poorer Malays, who are mostly gamblers, and carry on their work in a way very desultory and imperfect. Mr. Gray, who arrived in Sarawak last year with all necessary appliances for this kind of mining, and who had three years previous experience at the Cape fields, commenced operations in the Sentah river, but relinquished the attempt as unprofitable after an essay of ten days' or a fortnight's duration. I have been informed that in the opinion of the native diamond-washers, this gentleman never reached the true gem-bearing stratum; which may or may not have been the case. However this may be, a two weeks' exporation cannot be considered very satisfactory. One frequently hears of stones of good size and water being disposed of in Singapore as coming from Sarawak, and some are to be seen in Kuching now. They not seldom exhibit a pure lemon-yellow tinge, which is different from the straw colour of the Cape, and more valued. The large dimond (76½ carats), brought over from M'rau in the Sikaiam dirtrict of Dutch Borneo a year or two ago, is proof that stones of very considerable size are to be found in the island.

The Sentah is a tributary of the Penrissen branch of the Sarawak river. It is from this branch that Aquamarines are brought to Kuching. They seem to be very rare, and the only one which has come under my own notice was a mass of flaws, and useless as a gem.

To sum up the preceding notes. Of the known minerals of Sarawak, Antimony and Cinnabar are the only ores that have been explored on a large scale; of these, the difficulty of obtaining the first in remunerative quantity is daily increasing, while the yield of the second, at no time extraordinary, is capricious in the extreme. Arsenic, Gold, and Diamond have either proved failures, or do not tempt European capital. Coal has been tried and found wanting; but later discoveries with respect to its extent and quality, justify a some what confident belief that the

indubitably large deposits of this mineral in Sarawak, will shortly be re-opened on a scale not heretofore attempted in connexion with mining operations in this part of the East.

As the evidence stands, therefore, Sarawak cannot be looked upon as a mineral-producing country. What discoveries may be made in the future it is of course impossible to foretell; but it is not unreasonable to anticipate fresh discoveries of Antimony and Cinnabar; and, judging from the geological analogies existing between the N. W. Coast of Borneo, Banka, and the Malay Peninsula, of ores of tin and lead also. Such discoveries would be of much importance to the material welfare of Sarawak, and if made in any of the Sea-Dyak districts would be doubly beneficial. It is a regrettable circumstance that the Borneo Company—who hold a monopoly of all minerals in Sarawak, with the exceptions I believe, of coal, gold, and precious stones—have never instituted any system of prospecting the country beyond the limits of Sarawak Proper. It is true that their officers have now and again been despatched to look up traces of minerals, and have spent a few days in so doing, when weeks would have been insufficient for the fulfilment of the object in view. A superficial examination of a district in which strong traces of a mineral have been observed is, if unsucessful, worse than no examination at all, for it operates as a preventive against more thorough search being undertaken at a future day. The exploration for minerals in an open country is a sufficiently protracted and laborious affair—how much more so in a land like Borneo, densely clothed with a luxuriant vegetation.

In conclusion, whatever minerals may be awaiting discovery in the Territory, their importance can only be relative in comparison with that of the coal fields of N. W. Borneo. If these coal seams are available as a source of good average steaming fuel—and the partial statement of evidence which I have given above is most favourable to the idea that they are so available,—the probability is that they will be worked in Sarawak; and in that case their proximity to the great commercial emporium, and perhaps future naval arsenal of Singapore, will invest with a new interest this country, which, although playing a useful part in the gradual civilization of Borneo, and in the protection of trade on its coasts, has not otherwise any strong claims at present on the attention of the outside world.

COMPARATIVE STATEMENT OF THE ANNUAL EXPORT OF MINERALS AND MINERAL ORES FROM THE SARAWAK TERRITORY.

Years.	Antimony Ore.		Sulph. Antimony.		Oxide Antimony.		Cinnabar Ore.		Quicksilver.		Gold.		Diamond.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Flasks.	Value.	B'gkals	Value.	Value.
1864	488 1/20	$ 9,762	.. ...	$	.....	$	.....	$	.....	$	309 1/2	$ 9,482	$ .....
1865	463	„ 9,260	.....	„	.....	„	.....	„	.....	„	192 1/2	„ 5,394	„ 1,960
1866	438	„ 10,100	150	„ 3,750	.....	„	.....	„	.....	„	75	„ 2,250	„ 300
1867	147 3/20	„ 3,000	.....	„	.....	„	.....	„	.....	„	233	„ 6,998	„ 500
1868	1,710 10/20	„ 34,209	.....	„	.....	„	25 14/20	„ 2,547	.....	„	29 1/2	„ 890	„ 355
1869	1,444 14/20	„ 61,385	.....	„	.....	„	125	„ 47,125	.....	„	574	„ 14,228	„ 1,360
1870	1,699 12/20	„ 61,730	.....	„	.....	„	33	„ 8,396	732	„ 22,692	193 1/4	„ 5,879	„ 662
1871	978 17/20	„ 41,190	300	„ 10,500	.....	„	.....	.....	776	„ 24,992	165	„ 4,952	„ 1,050
1872	1,788 8/20	„ 86,926	533 7/20	„ 25,351	.....	„	.....	.....	1,733	„ 71,583	226 3/4	„ 7,485	„ .....
1873	.....	.....	1,667	„ 88,197	342	„ 10,672	.....	.....	1,505	„ 86,355	189 1/4	„ 6,262	„ 50,700*

* Including the large U'rau Diamond.